An early 19th century view of the sympathetic ganglia

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A work entitled *Dissertatio Inauguralis De Gangliorum ad Nervos Sympatheticos attinentium, fabrica officiis atque morbis* [An Inaugural Dissertation on the Composition Functions and Diseases of the Sympathetic Ganglia[1], Figure 1] was presented to the Faculty of Medicine of Edinburgh University on the 11 July 1831 and the degree of MD was awarded to Benjamin Archer Kent. In this dissertation Kent reviewed the state of knowledge about the sympathetic ganglia at that time, and attributed various clinical conditions to venous congestion and inflammation of these structures. His views crystallize early 19th century opinion on the subject.

Benjamin Archer Kent (Figure 2) was born in Abingdon in 1808, the son of a banker. When the bank failed in 1816 as a result of the financial depression which followed the Napoleonic wars, his father opened a school at nearby Radley Hall, and there the young Kent received his earlier education. At the age of 16 years he began a 5-year apprenticeship to an apothecary in Oxford, but after completing 4 years he decided to enter Edinburgh University where the medical school had become the most prestigious in the country, thereby hoping to obtain a doctorate in medicine in addition to the diploma of the Worshipful Society of Apothecaries. At the university, Kent became a fellow both of the Plinian Society, whose interests were in natural history, and of the Royal Medical Society to which he delivered a paper based on the subject of his dissertation. After graduation he practised medicine in England and in Australia, leading an adventurous life which touched on many of the dramatic events of his time. He died in London in 1864 and is the subject of a biography which is to be published[2] by the Royal Society of Medicine under the title of *Benjamin's Son*, and to which the translation of his work on the sympathetic ganglia, from the original Latin, will be appended.

DISSERTATIO INAUGURALIS

DE

GANGLIORUM

AD

NERVOS SYMPATHETICOS ATTINENTIUM

FABRICA, OFFICIIS ATQUE MORBIS:

QUAM,

ANNUENTE SUMMO NUMINE,

EX AUCTORITATE REVERENDI ADMODUM VIRI,

D. GEORGII BAIRD, SS. T.P.

ACADEMIAE EDINBURGENAE PRAEFECTI;

NECNON

AMPLISSIMI SENATUS ACADEMICI CONSENSU,

ET NOBILISSIMAE FACULTATIS MEDICAE DECRETO;

Pro Gradu Doctoris,

SUMMISQUE IN MEDICINA HONORIBUS AC PRIVILEGIIS

RITE ET LEGITIME CONSEQUENDIS;

ERUDITORUM EXAMINI SUBJICIT

BENJAMINUS ARCHER KENT,

Anglus,

SOCIETATIS REGIAE MEDICAE

SOCIUS EXTRAORDINARIUS

NECNON

SOCIETATIS PLINIANAE SOCIUS.

Nunquam non audeo.

IV. *Id. Julii, horâ locoque solitis.*

EDINBURGI:

EXCUDEBANT A. BALFOUR ET SOCII.

M.DCCC.XXXI.

Figure 1. Title page of Dr Benjamin Archer Kent's dissertation (reproduced from Benjamin's Son[2], by permission of Royal Society of Medicine Services Ltd)

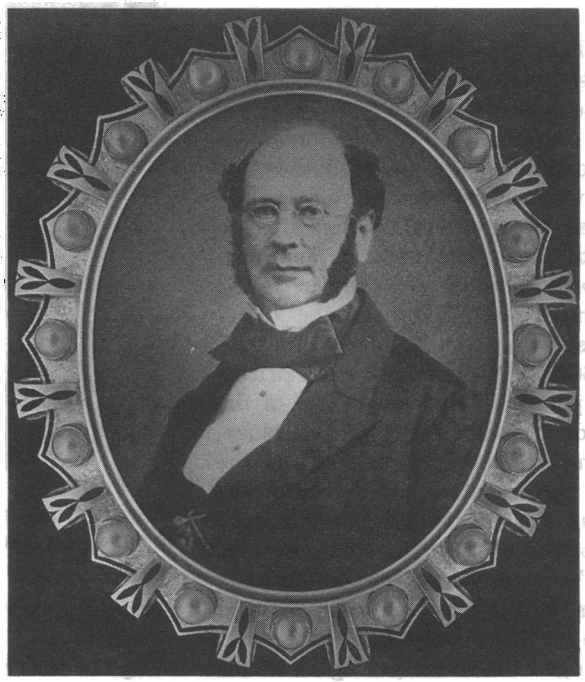

Figure 2. Dr Benjamin Archer Kent. Photograph taken about 1860 (reproduced from Benjamin's Son[2], by permission of Royal Society of Medicine Services Ltd)

The dissertation

Neuro-anatomy

Kent began his dissertation by describing the 'appearance, structure and properties of the Sympathetic Ganglia' as they were known to him. Almost at once we appreciate that there have been

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changes of meaning, for after mentioning their general shape and locations, we read: 'a small filament situated on the carotid artery reaches the Sixth nerve, and others are similarly found in the Vagus Nerve and the Glossopharyngeal branch of the Eighth Cranial Nerve'. This makes no sense in terms of modern anatomy and points to a change of nomenclature. So let us see how his interpretation of the anatomy had developed, starting in Greece in the second century AD.

The sympathetic trunk and ganglia

Galen of Pergamum (131-201 AD) identified the chain of nodules on what is now known as the sympathetic trunk and called them ganglia, the name given by Hippocrates to those swellings which are sometimes seen in relation to tendons. Galen also bestowed on these nodules the function of 'reinforcers of the nerves'[3]. Unfortunately he believed that the sympathetic trunk was derived from the vagus nerve, an error that was perpetuated by Vesalius in the illustrations to his great work on anatomy, *De Humani Corporis Fabrica*, published in 1543[4]. Vesalius named the sympathetic trunk the 'costal nerve' and of course illustrated it, as did Vidius in 1611[5]. Then in 1664[8] Willis, the father of British neurology, whose portrait forms the centre of the badge of the President of the Section of Neurology, considered that the sympathetic ganglia and the trunk, of current nomenclature, might unite the functions of various organs *sympathetically* in view of the wide distribution of their branches. He also renamed Vesalius's costal nerve the 'intercostal', because it ran over the origins of the ribs - another source of confusion for the unwary! It was Winslow, in 1732[7], who changed the name yet again to the great sympathetic nerve, because he thought that the *sympathies* of the body were controlled through it. The supposed origin of the great sympathetic nerve from the brain, which had remained the received opinion since the time of Galen, had been denied by Pourfour du Petit in 1710[8]. However, by 1771 many of the difficulties had been clarified, and William Hunter was able to give the pupils at his anatomy school in Great Windmill Street (which had been open for just 4 years) a clear description of the various major autonomic plexuses. We know this from reading the manuscript notes of his lectures that are to be found in the library of the Royal Society of Medicine[9]. These lectures were given by William Hunter himself, and by his assistant and surrogate son, William Hewson. The students were also told how the eighth pair of nerves (by which was meant the modern vagus) supplied the heart and lungs, and of the plentiful distribution of nerves to the abdominal viscera (Figure 3). So that Kent, writing in 1831, had a fairly correct view of the gross anatomy of the sympathetic trunk and ganglia.

Cranial nerves

With regard to the cranial nerves, these had also been classified by Galen, a classification that persisted for about 1500 years, with various slight modifications, until Vicq d'Azyr[10] revised it in 1781 on lines similar to those in use today. Galen had included the modern Abducent nerve as a part of the oculomotor, and he believed the facial and auditory nerves to be united as one nerve within a single bundle; his par vagum included the vagus, glossopharyngeal and spinal

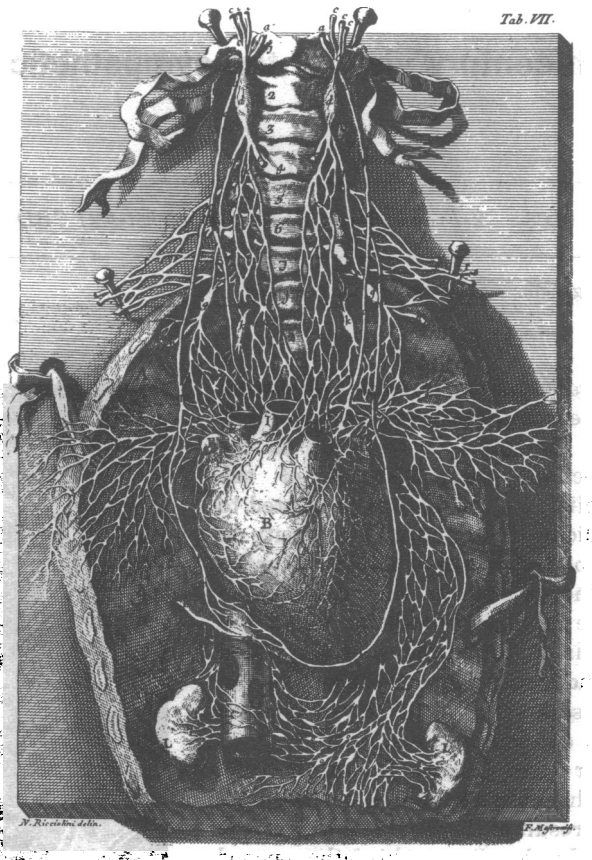

Figure 3. Illustration of the sympathetic nervous system, in Lancisi[18] De Gangliis Nervorum, *1745*

accessory nerves, and the hypoglossal was Galen's seventh.

By the 18th century many different classifications had been proposed and confusion reigned. For example, the fourth cranial nerve was known by some as the greater sympathetic, and branches of the facial nerve to the face were called the lesser sympathetic. Vicz d'Azyr[10], in an endeavour to bring about a rational nomenclature, separated Galen's facial nerve into two and called the firmer part the facial (VII) nerve, and the softer one the auditory (VIII). He named part of the par vagum the glossopharnygeal (IX), the rest becoming the vagus (X). Finally, he elevated the nervus accessorius to the status of a full cranial nerve as the accessory (XI), and the loquans became the hypoglossal (XII). However, confusion was still apparent even in 1831 as we have seen, and interpretation continues to be very trying when reading old texts. It is strange that Kent did not adopt Vicq d'Azyr's nomenclature, but he may have been following Winslow's earlier classification[7].

Sympathetic nervous system

Of course when he was writing Kent was quite unaware that there were two parts to the future autonomic nervous system: the parasympathetic and sympathetic components. They were not described until Gaskell[11] pointed the way and Langley[12] made his contributions at the beginning of the present century. In 1800 Bichat[13] developed the concept of an animal (la vie animale) and a vegetative (la vie organique) nervous system, the animal part being largely motor and the vegetative functions being concerned with those of which we are, generally speaking, unaware. It must be emphasized, however,

that this was far from a separation into central and sympathetic nervous systems, and much less into central, sympathetic and parasympathetic. When Kent was poring over his books, there was still a general lack of understanding of the difference between the dorsal spinal root ganglia and those of the sympathetic nerves, although they had been separated functionally and anatomically by Béclard in 1823[14]. Added to which, the differing functions of the anterior and posterior spinal roots had not even been elucidated, and the white and grey rami of the sympathetic ganglia were not yet differentiated.

Sympathetic ganglia

In his dissertation, Kent recounted various early descriptions of the structure of the ganglia and then concluded that there were three distinct parts. The first was 'a membrane surrounding the whole body [of the ganglion], the second a kind of medullary substance resembling woven filaments, the third a pulp which fills the cells or spaces between'. He described how the capsule was continuous with the sheaths of the nerves and dipped down into the ganglion, so that the fibres within it were deprived of any covering. Bichat[13] had identified 'cells' within the ganglia as early as 1800, but he misinterpreted his findings and failed to relate them to the nerve fibres. In fact the cells were not truly identified as of nervous origin until 5 years after Kent presented his dissertation, when Ehrenberg[15] saw them but still could not discover any union between cells and fibres. This connection was finally established by Deiters[16], but not until 1865. And further, a vigorous argument continued over the years, with which we need not be concerned, as to whether the ganglia contained fat or not and, if so, how much.

Neurophysiology

If there was a history of confusion about the anatomy of the ganglia, it was as nothing to the confusion about their function, and Kent recounts the various opinions that had been and were still held, some of which he, quite justifiably, dismissed out of hand. Vieussens[17], whose *Neurographia Universalis* was published in 1685, considered the ganglia to be receptacles in which the vital spirits were gathered and retained. Winslow[7], writing in 1732, thought that the scattered fibres of the sympathetic nerves transmitted some kind of nervous energy from the ganglia, which themselves functioned as semi-autonomous little brains. But Lancisi[18], writing in 1745, thought they had a similar function to the heart, and that by contracting hypothetical muscles in their capsules they impelled a fluid nervous force through the nerves. Meckel[19], Scarpa[20], Haas[21] and others, however, considered that the ganglia had no more complicated a function than to modify and rearrange the distribution of the fibres which entered them.

In the end Kent decided to adopt the views of Johnstone[22], a Worcester physician. This astute thinker, writing in 1795, considered the earlier opinions about the functions of the ganglia, and rejected most of them. He concluded that 'a new organisation or arrangement of the medullary substance' probably did take place within them, but beyond this concept they were also 'the instruments by which the motions of the heart and intestines are from the earliest to the latest periods of animal life, rendered uniformly involuntary'. For him they acted as 'checks on the usual powers of volition' which prevented the influence of the mind from extending to certain organs. They therefore functioned as little brains which were capable of dispensing nervous power long after all communication with the cerebrum was cut off. Furthermore, serious disease could exist in organs supplied by the sympathetic system, as then identified, without the subject being aware of it. He supported his ideas with animal experiments.

Various opinions were held by many other well-known physiologists, but they are more or less covered by what has been described. In 1801 Béclard[14] reiterated Johnstone's views, and added that '... these nerves thus form a unique system within the general nervous system. Both systems have intimate connections with each other [and] they have reciprocal influences, especially during illness'. Thus the idea of antagonistic action was appreciated by him, but was still a long way from realization.

Kent does not give us his own views on the mechanism of transmission of nervous energy, but it is reasonable to assume that he still accepted the concept of a fluid of some sort being conveyed along the nerve fibres. Lancisi's[18] idea that muscles in the capsules of the ganglia propelled this fluid has already been mentioned. Even in the 1771 manuscript of Hunter's lectures[9], we can read that 'Mr. Hewson is of the opinion that there is some secretion carried on in these ganglions, which may supply or assist the nerves'. In a following lecture, the great William Hunter himself quoted a theory, to which he gave no credence, that vibration was the means of nervous transmission, and went on to say:

> 'Another opinion is that the nerves are hollow, and that they contain Fluid. This is the general Opinion that they contain a Fluid somehow or other and that this Fluid conveys the Impression to the Nerves from the Mind: or from the Nerves to the Mind and that it is something like the Electrical Fluid for Velocity, but this is only conjecture, for it seems too deep and too much above our capacities ever to attain'.

Even if he did not know that, in one respect at least, he was on the right lines, one feels it would be nice to congratulate him on making a good guess about an electrical connection.

Clinico-pathological states

To quote once more from Dr Kent's dissertation[1], '... Now at last, it seems fitting to discuss the illnesses that arise from diseased ganglia or a diseased sympathetic system'.

Because the distribution of the sympathetic nerve fibres was to the viscera, including the heart, intestines, uterus and genitalia, it seemed logical to an 18th or early 19th century physician to assume that illnesses with symptoms related to these organs might be due to some kind of pathology in the sources of their nervous energy, and that these were the sympathetic ganglia. Indeed Lobstein[23] referred to 'neuralgia of the abdominal nerves'. Furthermore, there was at that time a strong desire to find a physical explanation for the so-called 'nervous disorders'[23].

For Kent (and for Lobstein) there were three common conditions whose symptoms particularly fell into this category and for which no other satisfactory explanation could be offered; they were hypochondriasis, hysteria and dyspepsia. It will at

once be observed that these diagnoses are no longer recognized, but they were very frequently made in 1831, and of course covered a multiplicity of conditions. Kent pointed out that all three were complaints that were confined to adults, and he followed Lobstein's argument[24] that since the sympathetic ganglia do not assume their true colour until adulthood, when they also become more solid, children were consequently protected, and those conditions which we are considering could not therefore arise until the ganglia were mature.

Let us put ourselves in the shoes of a physician in the year 1831, and ask what were the symptoms of these three conditions?

Hypochondriasis We may read in Lobstein's work on the sympathetic nerves (1823)[24], the history of a typical case of hypochondriasis which presented many of the symptoms of the condition:

'We observed a young girl in our clinic for many months, following the daily progress of her "hystericus morbus" through various parts of the nervous system. First there were spasms in the lower abdomen, followed by pain and swelling in the epigastrium associated with anxiety and attempts at vomiting; next there was a constriction of the lungs, a dry cough and palpitation of the heart; then came dysphagia, as if a morsel of food had stuck in the pharynx. Finally there was aphonia. This series of symptoms attacked the patient more than twenty times . . . and on any day the disease migrated, so to speak, to another territory of the nervous system. For it arose in the hypogastric and solar plexuses and then spread to the pulmonary and cardiac plexuses. From there it went to the nerves of the pharynx, and at last to the larynx . . . finally it descended to the pelvis, soon to repeat its previous route'.

We are not told the end of this sad story.

Hysteria The symptoms of hysteria as Kent saw them were superficially similar to those of hypochondriasis and need not be repeated, although he emphasized that the two conditions were really quite different on account of the specific association of hysteria with disorders of the uterus, and its consequent and almost invariable occurrence in females. Every symptom could be assigned to organs that are supplied by branches of the sympathetic system, particularly to the uterus and pelvis of course. Because of the need for the ganglia to mature, hysteria did not strike before adolescence, but it might then come suddenly and violently[1].

Dyspepsia According to Lobstein[24], and to Dr Kent[1] from whom I shall now quote at length, the symptoms of dyspepsia and hypochondriasis also overlapped. He described how both conditions were associated with 'unaccustomed and vague pain in the abdomen and in front of the heart, and unreasoning fears of imagined ills . . . [However], the mind is very seriously affected in hypochondriasis and is very little involved in dyspepsia'. Since we know how inflammation of bones, ligaments and cartilages can cause pain, though we are normally unaware of these structures, '. . . by the same token . . . the ganglia and the nerves . . . are afflicted with most severe pains at the onslaught of hypochondriasis'. These pains are quite different from ordinary ones and the sufferers use 'such harsh, almost ridiculous descriptions that they arouse laughter rather than pity'. Lobstein pointed out that the nervous connections of the affected parts were, according to him, quite obvious, so it was reasonable to conclude that the plexuses and their branches were the source of an irritation which '. . . is sent without delay to the sensorium in the brain', giving rise to further symptoms of 'pain, vertigo, defective vision, ringing in the ears, groundless fears, apoplexy, the fear of more serious diseases of the same kind, and above all an all-embracing sadness which almost becomes melancholic madness'.

Kent then examined the abdominal symptoms in more detail.

'Chief among these are an aversion to food, acid eructations, pain in the stomach, spasm after food, a tight belly, motions of an unhealthy colour passed from time to time and with difficulty, uncomfortable wind, increased excretion of pale and dilute urine and often difficulty in passing water'.

There was frequently also a dry cough and difficulty in breathing. In his opinion the latter stemmed from the solar plexus, which sends branches to the diaphragm, and the associated palpitation and cardiac irregularity could be attributed to involvement of the solar and cardiac plexuses[1].

Dyspepsia, Kent continued, was one of the most protean of conditions, which he felt could easily be understood when the diverse origins and connections of the nerves to the abdominal organs were considered. The small intestine was particularly affected, but the association with disease of the sympathetic ganglia and nerves was the same as in the other conditions he had considered. Philip[25] painted a vivid picture of the progress of the affection.

'First comes flatus, distension or even pain in the stomach and intestines, nausea, watery or painful eructation, stomach cramps, sleep that is disturbed by sad dreams, headache on rousing from sleep and a certain general feeling of weariness and weakness. To these are added tension and pain in the epigastrium, felt as far as the right hypochondrium, which is aggravated by pressure of the hand and accompanied by slight fever. When at last the disease enters its final stages, a sort of deformity of structure is apparent in one or many of the viscera'.

[In parenthesis, do we detect some similarity with the signs and symptoms of cholecystitis or appendicitis?]

Pathological changes

Dr Edward Hare[23] has pointed out that Lobstein's hypothesis, that was adopted by Kent, was still accepted by Gully[26] in 1837. Lobstein[24] purported to support his ideas with pathological studies that demonstrated congestion and signs of inflammation in the sympathetic nerves and ganglia, thus explaining the source of many and varied complaints. According to Béclard[14], Autenreith observed inflammation of the vagus, great sympathetic nerve and cardiac plexus in a case of whooping cough, and in a patient with diabetes Duncan found the abdominal sympathetic nerves to be three or four times their normal size. Lobstein[24] illustrated several examples of inflamed ganglia and nerves in his book on the sympathetic nerves, but unfortunately only one case was associated with hypochondriasis and the relevance of this and of the others is very doubtful. Dr Kent may have had his attention drawn to the weakness of the argument[23], for he says that the structure of the ganglia was found by Lobstein to be

'at least sometimes altered', rather than making a firm statement.

Dr Kent himself said, referring to hysteria and hypochondriasis,

'. . . we have until now been able to examine only a few cadavers of those who have died of these diseases or have suffered from them for a long time before death. The inspection of those which we were able to obtain clearly showed that the organs which serve the reproductive system, especially those of women, are the usual seat of the disease. For uterus and ovaries, along with the nerves supplying them, are found to suffer mostly from over-distension of their vessels'.

Unfortunately he did not illustrate or describe these cases in detail, and he added no description of the ganglia or nerves, neither did he have postmortem evidence of his own from cases of dyspepsia or hypochondriasis - presuming that some patients with these diagnoses must have died.

Discussion

We have seen how it is possible to base an apparently convincing but fallacious theory on a kind of sequential logic, itself based on sound premises. A theory is, however, only a tool with which to work until another more useful tool is developed, and this depends in its turn on the discovery of the further material on which it is based. Dr Kent was well aware of this, for he wrote:

'. . . A hypothesis only holds its ground as long as it is seen to be confirmed by the facts . . . it should be so lengthened or shortened, so increased or decreased, so, in short, fashioned in every way in order to adapt itself to include and govern new information'.

At the time when Dr Kent presented his dissertation, knowledge of the function of the nervous system was still rudimentary, for the great flowering of neurology did not take place until the middle and later years of the 19th century. It is significant that only three of the many works quoted by him were written during the previous 30 years. In 1831, as far as neurophysiology was concerned, the Cartesian or philosophical approach had not yet been completely replaced by the Newtonian or experimental method. Failure to support theory with hard evidence was the rock upon which Kent's ideas and those of his mentors foundered.

Kent was at the beginning of his career when he took his MD degree. When he acquired the Membership of the Royal College of Physicians at the age of 51 years, he was not required to take an examination but he might well have been aware of the dramatic changes that were taking place in the extent of knowledge of the function of the nervous system. Major discoveries that would have been beyond his imagination had yet to be made. He would have been sad, but probably not surprised, to know that his ideas had ceased to be acceptable, but he would also have been the first to enquire about the revelations of the years to come. After a plea for more careful examination of the sympathetic nervous system during autopsies, his dissertation concludes with the following sentences:

'Let each man for himself, with his own eyes, study the changes caused by diseases; let him trace the various interlacings and harmonies between each part of the body. Then at last, he can bring succour to failing health at its very origin, and he might hope to drive the very dangerous enemy from its deepest hiding places'.

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